WHAT IS CLAIMED IS:

1. A method of phosphorylating a protein comprising contacting said protein with a soluble G1cNAc-phosphotransferase; and producing a phosphorylated protein.

2. The method of Claim 1, wherein said protein comprises an asparagine-linked oligosaccharide with a high mannose structure.

3. The method of Claim 1, wherein said soluble G1cNAc-phosphotransferase comprises the amino acid sequence in SEQ ID NO:2.

4. The method of Claim 1, wherein said soluble G1cNAc-phosphotransferase comprises an α subunit, a β subunit and a site-specific proteolytic cleavage site interposed between said α and β subunits, wherein said proteolytic cleavage site is not natural to said G1cNAc-phosphotransferase.

5. The method of Claim 4, wherein said α subunit is encoded by nucleotides 165 to 2948 of SEQ ID NO:3, or a sequence that hybridizes under stringent conditions to the complement of nucleotides 165 to 2948 of SEQ ID NO:3.

6. The method of Claim 4, wherein said β-subunit is encoded by nucleotides 2949 to 3932 of SEQ ID NO:3, or a sequence that hybridizes under stringent conditions to the complement of nucleotides 2949 to 3932 of SEQ ID NO:3.

7. The method of Claim 4, wherein said α-subunit comprises amino acids 1-928 of SEQ ID NO:4.

8. The method of Claim 4, wherein said β subunit amino acids 1 to 328 of SEQ ID NO:5.

9. The method of Claim 4, wherein said soluble G1cNAc-phosphotransferase further comprises a γ subunit.

10. The method of Claim 9, wherein said γ subunit is encoded by SEQ ID NO:6, or a nucleotide sequence that hybridizes under stringent conditions to the complement of SEQ ID NO:6.

11. The method of Claim 9, wherein said γ subunit comprises the amino acid sequence of SEQ ID NO:7.

12. The method of Claim 1, wherein said site-specific proteolytic cleavage site is selected from the group consisting of a Furin proteolytic cleavage site, a Factor Xa proteolytic cleavage site, a Enterokinase proteolytic cleavage site, and a Genease I proteolytic cleavage site.

13. The method of Claim 12, wherein said site-specific proteolytic cleavage site is a Furin proteolytic cleavage site.

14. The method of Claim 13, wherein said Furin proteolytic cleavage site comprises SEQ ID NO:22.

15. The method of Claim 1, wherein said protein is a lysosomal hydrolase.

16. The method of Claim 15, wherein said lysosomal enzyme is selected from the group consisting of α-glucosidase, α-iduronidase, β-galactosidase A, arylsulfatase, N-acetylgalactosamine-α -sulfatase, β-galactosidase, iduronate 2-sulfatase, ceramidase, galactocerebrosidase, β -glucoronidase, Heparan N-sulfatase, N-Acetyl-α-glucosaminidase, Acetyl CoA- -glucosaminide N-acetyl transferase, N-acetyl-glucosamine-6 sulfatase, Galactose 6-sulfatase, Arylsulfatase A, Arylsulfatase B, Arylsulfatase C, Arylsulfatase A

Cerebroside, Ganglioside, Acid β-galactosidase G_{M1} Galglioside, Acid - galactosidase, Hexosaminidase A, Hexosaminidase B, α-fucosidase, α-N-Acetyl galactosaminidase, Glycoprotein Neuraminidase, Aspartylglucosamine amidase, Acid Lipase, Acid Ceramidase, Lysosomal Sphingomyelinase , Sphingomyelinase, and Glucocerebrosidase β-Glucosidase.

17. The method of Claim 1, further comprising contacting said phosphoryalated protein with an isolated phosphodiester α-G1cNAcase.

18. The method of Claim 17, wherein said phosphodiester α-G1cNAcase comprises the amino acid sequence of SEQ ID NO:18.

19. The method of Claim 17, wherein said phosphodiester α-GlcNAcase is encoded by a nucleotide sequence comprising SEQ ID NO:17 or a nucleotide sequence that hybridizes under stringent conditions to the complement of SEQ ID NO:17.

20. The method of Claim 1, wherein prior to said contacting the method comprises: culturing a host cell which comprises an isolated polynucleotide encoding soluble G1cNAc-phosphotransferase for a time under conditions suitable for expression of the soluble G1cNAc-phosphotransferase; and isolating said soluble G1cNAc-phosphotransferase.

21. The method of Claim 1, wherein prior to said contacting the method comprises culturing a host cell which comprises an isolated polynucleotide encoding soluble G1cNAc-phosphotransferase for a time under conditions suitable for expression of the soluble G1cNAc-phosphotransferase, wherein said soluble G1cNAc-phosphotransferase comprises an αsubunit, a β subunit

and a site-specific protelytic cleavage site interposed between said α and β subunits, wherein said proteolytic cleavage site is not endogenous to G1cNAc-phosphotransferase;isolating said soluble G1cNAc-phosphotransferase; cleaving said isolated soluble G1cNAc-phosphotransferase with a proteolytic enzyme specific for said proteolytic cleavage site; and mixing said α and βsubunits with a γ subunit of G1cNAc-phosphotransferase.

22. An isolated polypeptide comprising SEQ ID NO:2.

23. An isolated polynucleotide which encodes the polypeptide of Claim 22.

24. An isolated polynucleotide comprising SEQ ID NO: 1.

25. An isolated polynucleotide, which hybridizes under stringent conditions to the isolated polynucleotide SEQ ID NO:1 or the complement of SEQ ID NO:1.

26. An G1cNAc-phosphotransferase comprising an α subunit, a β subunit and a site-specific proteolytic cleavage site interposed between said α and β subunits, wherein said site-specific proteolytic cleavage site is not endogenous to G1cNAc-phosphotransferase.

27. An isolated polynucleotide, which encodes the GlcNAc-phosphotransferase of Claim 26.

28. The G1cNAc-phosphotransferase of Claim 26, wherein said α subunit is encoded by nucleotides 165 to 2948 of SEQ ID NO:3, or a sequence that hybridizes under stringent conditions to the complement of nucleotides 165 to 2948 of SEQ ID NO:3.

29. The G1cNAc-phosphotransferase of Claim 26, wherein said β-subunit is encoded by nucleotides 2949 to 3932 of SEQ ID NO:3, or a sequence that hybridizes under stringent conditions to the complement of nucleotides 2949 to 3932 of SEQ ID NO:3.

30. The G1cNAc-phosphotransferase of Claim 30, wherein said α-subunit comprises amino acids 1-928 of SEQ ID NO:4.

31. The G1cNAc-phosphotransferase of Claim 26, wherein said β subunit amino acids 1 to 328 of SEQ ID NO:5.

32. The G1cNAc-phosphotransferase of Claim 26, wherein said G1cNAc-phosphotransferase further comprises a γ subunit.

33. The G1cNAc-phosphotransferase of Claim 32, wherein said γ subunit is encoded by SEQ ID NO:6, or a nucleotide sequence that hybridizes under stringent conditions to the complement of SEQ ID NO:6.

34. The G1cNAc-phosphotransferase of Claim 32, wherein said γ subunit comprises the amino acid sequence of SEQ ID NO:7.

35. The G1cNAc-phosphotransferase of Claim 26, wherein said site-specific proteolytic cleavage site is selected from the group consisting of a Furin proteolytic cleavage site, a Factor Xa proteolytic cleavage site, a Enterokinase proteolytic cleavage site, and a Genease I proteolytic cleavage site.

36. The G1cNAc-phosphotransferase of Claim 35, wherein said site-specific proteolytic cleavage site is a Furin proteolytic cleavage site.

37. The G1cNAc-phosphotransferase of Claim 36, wherein said Furin proteolytic cleavage site comprises SEQ ID NO:22.

38. A vector comprising the isolated polynucleotide of Claim 23.

39. A vector comprising the isolated polynucleotide of Claim 24.

40. A vector comprising the isolated polynucleotide of Claim 25.

41. A vector comprising the isolated polynucleotide of Claim 27.

42. A host cell comprising the isolated polynucleotide of Claim 23.

43. A host cell comprising the isolated polynucleotide of Claim 24.

44. A host cell comprising the isolated polynucleotide of Claim 25.

45. A host cell comprising the isolated polynucleotide of Claim 27.

46. A method of producing an α and β subunit G1cNAc-phosphotransferase polyprotein comprising culturing the host cell of Claim 42 for a time and under conditions suitable for expression of the α and β subunit G1cNAc-phosphotransferase polyprotein and collecting the α and β subunit G1cNAc-phosphotransferase polyprotein produced.

47. . The method of Claim 46, wherein prior to said collecting, the α and β G1cNAc-phosphotransferase subunits are cleaved in the host cell by a site specfic protease which is expressed in the cell, wherein said protease is specific for a protease cleavage site positioned between said α and β subunits.

48. The method of Claim 46, further comprising after said collecting, the α and β subunits are cleaved with a protease specific for a protease cleavage site positioned between said α and β subunits.

49. A method of producing an α and β subunit G1cNAc-phosphotransferase polyprotein comprising culturing the host cell of Claim 45 for a time and under conditions suitable for expression of the α and β subunit G1cNAc-

phosphotransferase polyprotein and collecting the α and β subunit G1cNAc-phosphotransferase polyprotein produced.

50. . The method of Claim 49, wherein prior to said collecting, the α and β G1cNAc-phosphotransferase subunits are cleaved in the host cell by a site specfic protease which is expressed in the cell, wherein said protease is specific for a protease cleavage site positioned between said α and β subunits.

51. The method of Claim 49, further comprising after said collecting, the α and β subunits are cleaved with a protease specific for a protease cleavage site positioned between said α and β subunits.

52. A phosphorylated protein obtained by the method of Claim 1.

53. A phosphorylated protein obtained by the method of Claim 17.

54. A method of treating a patient suffering from a lysosomal storage disease comprising contacting a lysosomal hydrolase with the GlcNAc-phosphotransferase of Claim 26 to produce a lysosomal hydrolase with an N-acetylglucosamine-1-phosphate; removing said N-acetylglucosamine by contacting said lysosomal hydrolase with a phosphodiester α-GlcNAcase to produce a phosphorylated lysosomal hydrolase isolating said phosphorylated lysosomal hydrolase; and administering an amount sufficient to treat said disease the isolated phosphorylated lysosomal hydrolase.

55. A method of treating a patient suffering from a lysosomal storage disease comprising contacting a lysosomal hydrolase with the GlcNAc-phosphotransferase of Claim 32 to produce a lysosomal hydrolase with an N-acetylglucosamine-1-phosphate; removing said N-acetylglucosamine by

contacting said lysosomal hydrolase with a phosphodiester α-GlcNAcase to produce a phosphorylated lysosomal hydrolase isolating said phosphorylated lysosomal hydrolase; and administering an amount sufficient to treat said disease the isolated phosphorylated lysosomal hydrolase.